with G. L. Johnson's kind regards

(11.)

# OBSERVATIONS ON THE MACULA LUTEA.

BY

GEORGE LINDSAY JOHNSON, M.D. (CANTAB.), F.R.C.S. (LONDON).



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# OBSERVATIONS ON THE MACULA LUTEA.

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## HISTOLOGY OF THE HUMAN MACULA (*Continued*).

### C.—THE MEMBRANA LIMITANS EXTERNA.

THE older writers describe the membrana limitans externa as a true membrane; later authors consider it a fenestrated membrane; my observations however tend to show that neither of these views is correct. No membrane separates the bacillary from the outer granular layer, but coarse fibres run parallel to the plane of the retina intertwining with the basal portion of the rods and cones, just as the weft of a fabric interlaces the warp, forming a supporting tissue for the bacillary layer.

If we examine the vertical sections illustrated in Figs. 15 to 20 we find that in thin sections the membrana limitans externa appears as a straight rouletted line, which is the appearance that interlaced fibres have when viewed vertically, and this is confirmed by transverse sections as shown in Fig. 23, which is taken from a section only slightly oblique, so that three or four rows of these stout intertwining fibres can be seen.

The so-called membrana limitans externa is invariably a straight line when seen in vertical sections. Whenever it appears wavy it is due to shrinkage of the specimen. It is this straight line formed by the intertwining fibres which has hitherto been regarded as the section of a membrane. Transverse sections now show us the real structure. There are only two membranes in the retina, the membrana limitans interna and the membrana terminans, the latter contigu-

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ous with the choroidal membrana vitrea (membrane of Bruch) as I previously described. Between these two membranes the retina lies as an uninterrupted structure.

### D.—THE OUTER GRANULAR LAYER.

Before discussing this layer I think it necessary to repeat, what I said in my last paper, viz.:—that my observations led me to believe that the ultimate optic nerve fibrils run continuously from the optic nerve to the spherules in the hexagonal layer. I not only find this confirmed by subsequent observation, but I further find two distinct forms of nerve fibrils in every layer of the retina, and even in the optic nerve itself. These two kinds of nerve fibrils can be distinguished by their mode of insulation and can be traced to the cones and rods respectively. I shall therefore refer to them as "cone-fibrils" and "rod-fibrils."

The cone-fibrils are protected throughout their entire course from the optic nerve to the spherules in the hexagonal layer by sheaths. The so-called Müller fibres, as Borysiekiewicz [1] has already pointed out, are not sustaining fibres, but merely the continuations of the cone-sheaths. In these sheaths the cone-fibrils lie embedded in a protoplasmic substance, supported by radiating fibrillæ. The rod-fibrils are insulated in various ways in the several layers and are not surrounded by this protoplasmic substance.

It suggests itself to me that the protoplasmic mass in which the cone-fibrils are embedded in the sheaths may be a transparent modification of the white substance of Schwann. If this is so, opaque nerve-fibres may be due to this high differentiation of the white substance of Schwann being arrested during development.

I am further inclined to believe that we may regard the cone-fibrils as the axis-cylinders of specialized medullated nerve-fibres. These axis-cylinders are surrounded by the above mentioned modified form of the white substance of Schwann surrounded by sheaths which are likewise differentiated, being transparent, and without the nodes of Ranvier.

[1] *Weitere Untersuchungen über den feineren Bau der Netzhaut.* Wien, 1894.

If we consider the cone-sheaths, their contents, and the fibrils in their midst, as constituting specialized medullated fibres, we must regard the rod-fibrils as non-medullated fibres, likewise specialized and variously insulated. In the bacillary layer as shown in Fig. 11 and Fig. 12 the axis-cylinders of these non-medullated fibres run through a sheath, but are not surrounded by the modified substance of Schwann.

In other words we might substitute the terms medullated and non-medullated fibres for cones and rods respectively.

I may here mention that in the optic nerve and the inner layers of the retina I meet with a third form of nerve fibres which seem to me to belong to the sympathetic system, and these can be traced to the retinal blood-vessels and capillaries.

In the preparation of the retina for microscopic examination the protoplasmic mass contained in the sheaths which bear the cone-fibrils frequently coagulates, and contracts under the influence of reagents so that nodules are formed which stain darker than the rest and vacuoles are formed. These nodules and vacuoles have been considered normal and consequently misinterpreted.

The ultimate nerve-fibrils, both the cone-fibrils and those connected with rods, are exceedingly fine, varying from $0.1\mu$ to $0.3\mu$ and therefore can only be seen with very high magnification. As specimens prepared by the Ramon y Cajal and Golgi methods are of necessity thick, and have usually to be examined without a cover slip, they will not bear more than 100 to 300 diameters magnification, and therefore these very fine fibrils cannot be seen in specimens prepared by these methods.

It appears to me that what has been described as revealed by these methods are the nerve sheaths and the sustaining networks, and that frequently the stain has run into and between the meshes of the network, giving rise to those remarkable appearances of which other methods do not reveal the slightest trace.

It is only by methods which admit of very high magnification that the course of such an infinite number of minute

nerve-fibrils can be traced through the neuroglia and other insulating and sustaining structures. It is only by means of the most recent methods and appliances that sufficiently perfect sections can be obtained, and I have moreover found microphotography of the very greatest assistance. Microphotography not only reproduces what we see, but it enables us to compare successive fields of view in a manner which is impossible by any other means.

**The outer granular layer** (of which a transverse section is represented in Fig. 21) consists of a network, in the meshes of which the granules characteristic of this layer are suspended, and through which the prolongations of the cone-sheaths, the so-called Müller fibres, run. The section through these Müller sheaths and their protoplasmic contents stain dark, and appear in the photograph as irregular patches. Any doubt as to these irregular dark patches—shown in Fig. 21—being actually transverse sections of the sheaths which bear the cone-fibrils, has been removed from my mind by the appearance presented by very oblique sections through the layer, and I therefore subjoin a microphotograph of such a section in Fig. 22. This section having been obtained in the macula region, the sheaths are numerous, and close to one another. I have specimens of transverse sections in which the knife has removed the hardened nerve-fibril from the centre of its protoplasmic surroundings, so that a small round space can be seen in the centre of each of the Müller sheaths.

On closer examination of the granules we find a rod-fibril passing through the centre of each, and we can see the radiating fibrillæ which hold it in position. These granules are filled with a granular mass which affords additional insulation to the nerve-fibrils suspended in their centre.

In vertical sections the rod-fibrils can be traced through each successive granule, so that we may picture each of these ultimate nerve-fibrils running through the granules like a string threaded with beads.

The granules of the outer granular layer, though slightly smaller, resemble in structure the spherules in the hexagonal

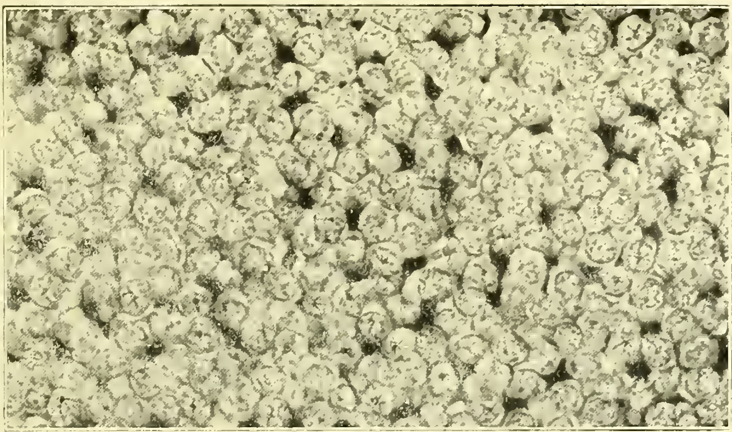

FIG. 21.

Transverse section through the outer granular layer x 1000 diameters. The cone-sheaths are seen as small irregular dark patches, the granules show the ultimate nerve-fibrils (rod-fibrils) passing through their centres supported by radiating fibrillæ.

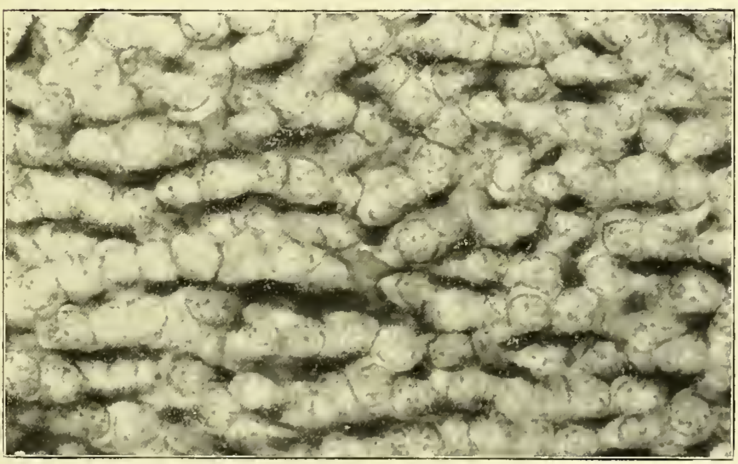

FIG. 22.

Oblique section through the outer granular layer x 1000 diameters, showing the cone-sheaths passing between the granules which carry the rod-fibrils.

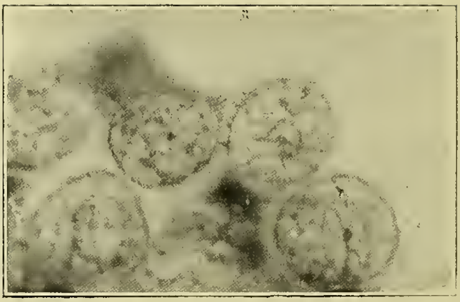

Fig. 23.

Transverse section through a few granules x 3000 diameters. The nerve fibril in the centre and the radiating supporting fibrillæ embedded in the granular substance which fills the granule can be clearly seen.

Fig. 24.

Transverse section (slightly oblique) through the basal portion of the bacillary layer and the outer granular layer x 1000 diameters. This figure shows on the right-hand side the rods and cones, on the left, the outer granular layer. Between the two, in the centre of the picture, we see the cone-bases and the large granules, and intertwining these the coarse fibres of the membrana limitans.

layer, as will be seen from the microphotograph shown in Fig. 23, which represents a few granules magnified to the same extent as the spherule in the hexagonal layer depicted in Fig. 10.

In addition to the granules which support the rod-fibrils, other large granules are situated in the thickened portion of the Müller or cone-sheaths on the inner side of the membrana limitans and in close contiguity with it. The Müller sheaths attain their greatest width at the limiting membrane; outwards they taper off very gradually to form the base of the cones, inwards they narrow rapidly after having enclosed the above mentioned large granule. As the membrana limitans externa consists, as I have said, of stout fibres which entwine the base of the cone-sheaths just outside the point where these large spherules lie, we would expect it to be visible in slightly oblique transverse sections between the bacillary layer and the outer granular layer encircling cone-bases or large spherules. Such is in reality the case, as will be seen in the microphotograph, Fig. 24.

The section represented in that photograph is taken from the outer papillary or fourth area; there the cones are much more numerous, and much smaller in diameter than in the peripheral area; therefore the bacillary layer appears different from that represented in Fig. 11, although the magnification is the same.

The outer granular layer does not differ materially in appearance in the various parts of the retina, with the sole exception of the inner papillary or third area. There where we find the third system of the bacillary layer, we notice, as shown in Fig. 25, besides the granules and the cone-sheaths, a large number of considerably smaller granules which contain a more homogeneous substance than the granular mass which fills the larger granules.

Why there should be an additional form of granules so much smaller than the rest, and staining so differently, and why they should only be found in this small inner papillary area, I have been unable to discover.

With the above sole exception the outer granular layer

differs in the various parts of the retina in width only, being narrowest in the peripheral area. Of course, as the number of cones increases, we find a larger number of sheaths, while the granule strings diminish proportionately.

Michael Foster, in the latest edition of his *Physiology* (p. 1205), states that the rods relatively numerous at the peripheral parts of the macula gradually grow scanty, and finally disappear, so that cones only are left at the fovea itself. I quite agree with this statement, except that I find at the fovea itself, and even at its very centre, every cone is surrounded by a single circle of rods.

In vertical sections this may not be very apparent when examining the bacillary layer itself, but it can be clearly seen when the outer granular layer is examined. There we find the cone-sheaths, the so-called Müller fibres, close together, but between each pair of these fibres a fine rod-fibril, supported by granules, can be distinctly discerned.

In fact we may say that in all portions of the retina we find specialized medullated and specialized non-medullated nerve-fibres; the former increasing in frequency as we approach the fovea, until we find every medullated fibre surrounded only by a single circle of extremely delicate non-medullated fibres.

In other words, the non-medullated fibres (rod-fibrils) are protected in the bacillary layer by sheaths similar to those which protect the cone-fibrils. Hence, when the bacillary layer only is viewed vertically we find a marked difference between rods and cones in the peripheral area, so that we can distinguish them without hesitation, but as the structure becomes more delicate, this difference gradually diminishes until at length at the fovea itself the appearance of the two kinds of fibres is identical. A glance at Fig. 19, showing the fifth system of the bacillary layer, will make this more evident. But we must bear in mind that the difference between the rod-sheaths and the cone-sheaths in the bacillary layer is that the latter only are filled with a protoplasmic substance, a differentiated transparent medullary sheath, and that the difference therefore can be seen in transverse sections. When we come to the outer granular layer we

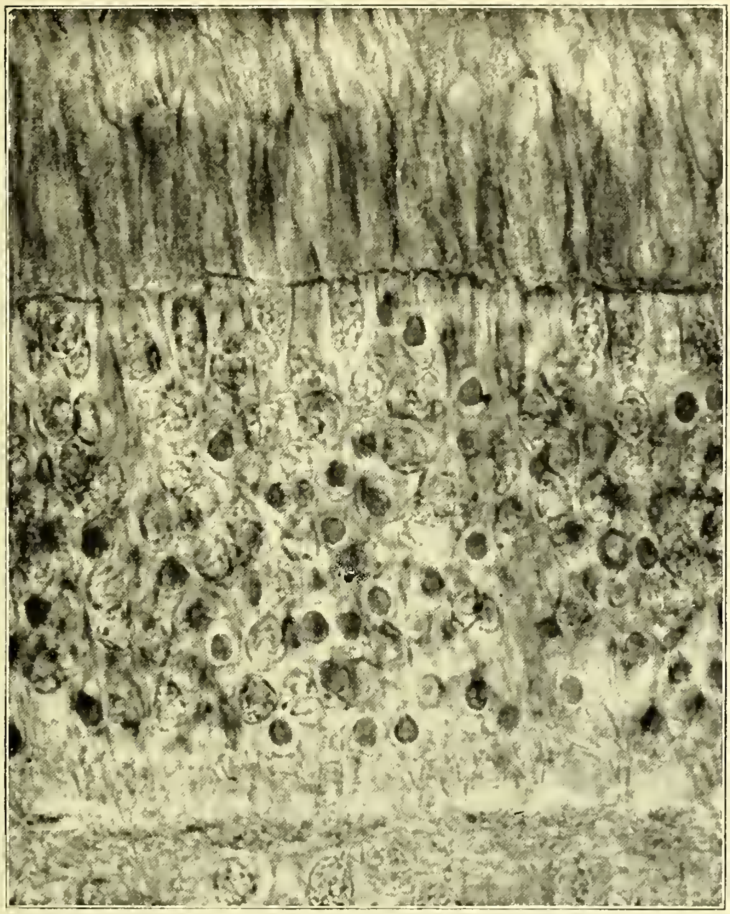

FIG. 25.

Vertical section through the outer molecular and outer granular layers in the third or inner papillary area, showing the two different forms of granules found only in this portion of the retina. The large granules contained in the Müller sheaths in contiguity with the membrana limitans can also be seen. x 1000 diameters.

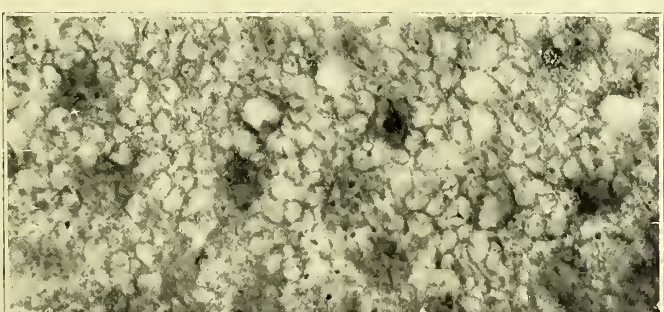

FIG. 26.

Transverse section through the outer molecular layer x 1000 diameters. This picture shows the cone-sheaths as dark patches passing through a network, in each of which we find a rod-fibril supported by radiating fibrillæ.

can distinguish between them in vertical sections because the cone-sheaths continue as so-called Müller fibres, bearing the cone-fibril in their centre surrounded by a medullary sheath, whilst the non-medullated rod-fibrils emerge from their bacillary sheaths, and traverse successive granules until they enter the meshes of the outer molecular layer.

The specimen represented in Fig. 24 was obtained at the edge of the foveal pit. In this transverse section the rods and cones can be clearly distinguished. Comparing this picture with Fig. 11, given in my previous paper, and representing a section from the peripheral area, we find that the cones and rods are considerably more delicate at the fovea, and that the rods are much fewer in number, but that contrary to the generally accepted view there are rods present throughout the macula and at the fovea itself.

### E.—THE OUTER MOLECULAR LAYER.

The outer molecular layer consists of a fine network in each of the meshes of which we find a rod-fibril supported by radiating fibrillæ, except there where the constricted cone-sheaths (Müller fibres) pass. This is shown in Fig. 26.

A comparison between this transverse section of the outer molecular layer and the transverse sections shown in this and my previous articles, seems to confirm the description I have given of the mode of insulation of the cone- and rod-fibrils. In fact to my mind the similarity between the outer molecular layer (Fig. 26) and the distal portion of the rods and cones (Fig. 12) as seen in transverse sections is most striking, and confirms to my mind the conclusion that we are in the presence of continuous medullated and non-medullated fibres differentiated for the purposes of this special sense organ.

The outer molecular layer when viewed vertically appears throughout the retina as a narrow streak of close network interrupted at regular intervals by the Müller sheaths (cone-fibre sheaths) which pass through it. Therefore of course the interruptions occur at shorter intervals in those parts of the retina in which cones are more abundant. The appear-

ance of the layer is shown in Figs. 24 and 26 as well as in the accompanying folded microphotograph.

If we consider the blood supply only, we can divide the retina into three distinct and sharply defined parts. An inner part with large blood-vessels, a middle part with capillaries only, and an outer part in which both capillaries and blood-vessels are wanting. It is the molecular layers which divide these three zones. Outside of the outer molecular layer, which we are now discussing, there is no apparent blood supply, but immediately we pass inside this layer we find numerous capillaries, and in the same way we do not find large blood-vessels until we have passed the inner molecular layer. Therefore these molecular layers must play an important part in regulating the areas of the blood and lymph supply. Besides this, however, the close network of the molecular layers entwining the cone-sheaths which pass through them, constitute the chief sustaining plexi of the retina. In specimens which have been prepared with unnecessarily severe reagents I frequently find the tender network of the granular layers as well as the rod-fibrils entirely destroyed and the granules washed out. The skeleton of the retina—if I may so call it—remains behind, consisting merely of the cone-sheath sustained by the so called limiting membranes and the molecular layers.

### F.—THE MACULA PLEXUS.

Various authors have pointed out that at the macula region a special differentiation occurs internally to the outer granular layer. Some have referred to this as the inner portion of the outer granular layer itself, others describe it as a separate layer. Dimmer [1] has devoted considerable attention to this layer, and reviews the opinions held by previous investigators. In the text-books, as a rule, little or no reference is found to this layer. Up to the present the opinion has prevailed that this special differentiation is due to a sloping of the cone-fibres away from the fovea.

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[1] *Beiträge zur Anatomie u. Phys. der Macula Lutea des Menschen.* Leipsic und Wien, 1894.

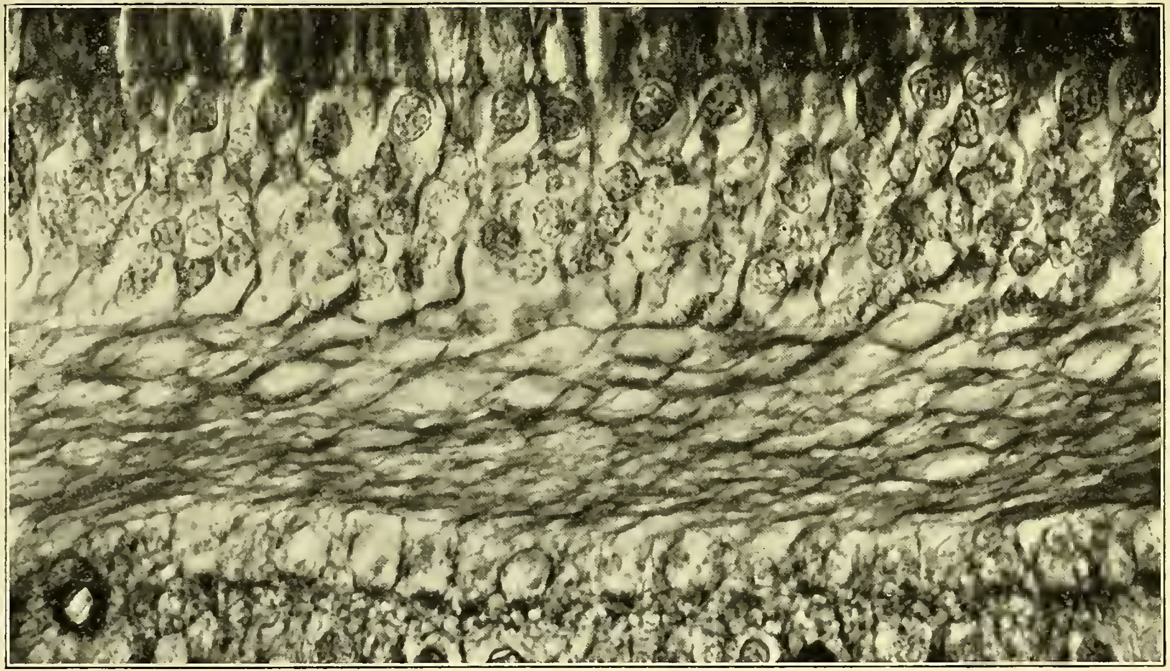

FIG. 27.

Vertical section through the retina near the point where the macula plexus first appears, showing the border layer well defined. x 1000 diameters.

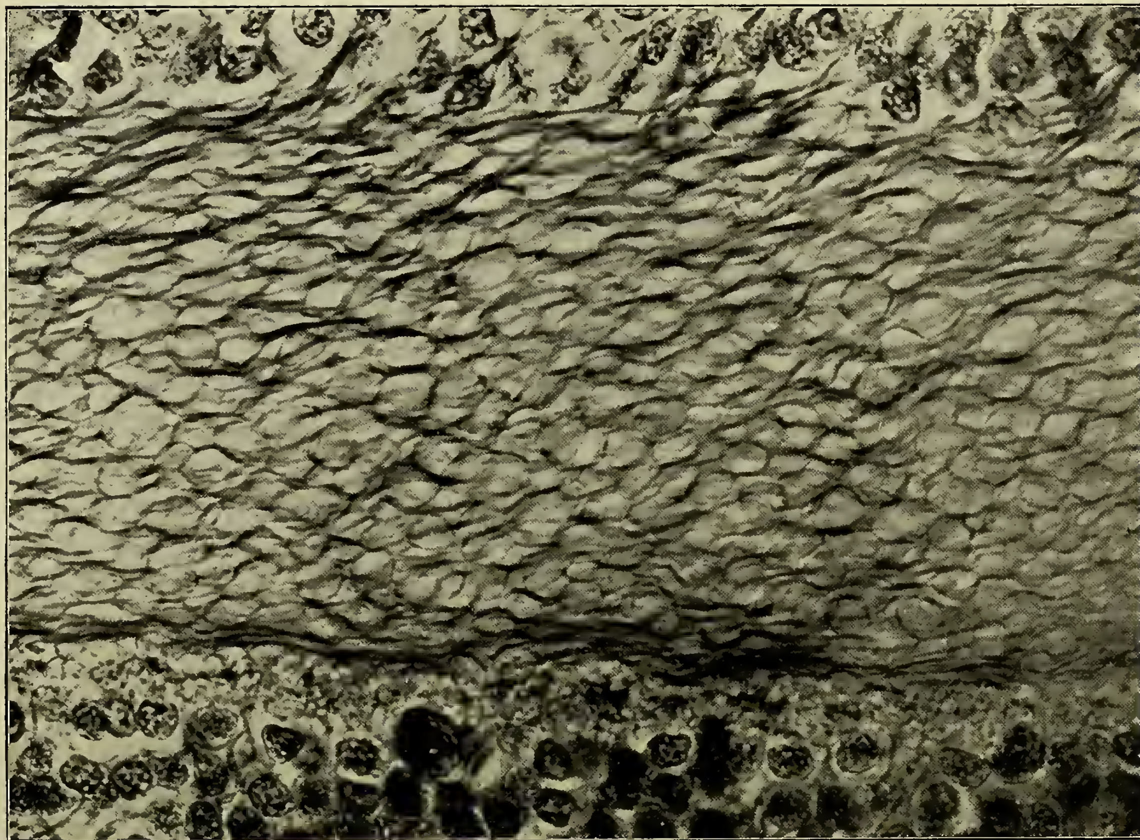

FIG. 28.

Vertical section through the retina showing the macula plexus at its broadest point near the fovea. At this point the border layer ceases. x 1000 diameters.

I find this in the main correct, but evidently what has been described as cone-fibres must be regarded as sheaths carrying the cone-fibril in their centres, or, in other words, the medullated fibres of the retina. These cone-sheaths slant away from the fovea and are sustained by a network of fine connective-tissue fibres. Moreover the meshes of this fine network sustain the delicate rod-fibrillæ. Near the fovea, where each rod alternates with a cone, the slanting sheaths are very numerous and lie close together; and as moreover they are wavy in their course, the whole structure presents the appearance of a coarse-meshed network when viewed with low powers, as will be seen on reference to the folded microphotograph. With high powers the sustaining network and the rod-fibrils can be seen as shown in Fig. 28. Farther away from the fovea the cone-sheaths are somewhat less numerous, and their course can be more clearly followed (see Fig. 27). The network which sustains the slanting cone-sheaths, as well as the delicate rod-fibrils which run through the meshes of this network, become easily destroyed during the preparation of the specimens, leaving the sloping cone-sheaths behind. This accounts for the description hitherto given, and the names selected by various authors. Max Schultze speaks of a fibrous modification of the inner half of the outer granular layer. Henle calls it the outer fibre layer. It has also been called the neuro-epithelium layer and the cone-fibre layer. I propose to name it *the macula plexus.*

The first distinct trace of the macula plexus is to be met with at about 1 *mm* from the outer edge of the disc; from this point it widens gradually until it comes within 0.2 *mm* of the fovea, where it narrows again, ceasing abruptly at the fovea itself. On the other side of the fovea it appears again, attaining its greatest width at about 0.2 *mm* from it; and then it continues narrowing gradually, until it finally ceases to be visible at the termination of the fifth system. The annexed folded microphotograph shows the entire extent of this plexus. Fig. 28 is a microphotograph taken at the widest portion, Fig. 27 is a microphotograph taken at about half a millimetre from the point where it first appears.

## G.—THE MACULA PLEXUS BORDER LAYER.

Between the macula plexus and the outer molecular layer I find a further differentiation so marked that I think it must be described as a separate layer, and I propose giving it the above name.

This layer runs all along the inner border of the macula plexus, as can be clearly seen in the accompanying folded microphotograph; it is of equal width throughout its course, measuring about 10 $\mu$. Near the fovea it gradually narrows to a point ceasing just before the plexus itself. It is shown very clearly in Fig. 27, but is nearly absent in the part shown in Fig. 28.

In this layer the cone-sheaths run at right angles to the plain of the retina, being sustained by a network, through the meshes of which the rod-fibrils run.

From this border layer cone-sheaths and rod-fibrils enter the outer molecular layer, which forms all along the well marked inner edge of the border layer.

### *Recapitulation.*

The retina is a continuous uninterrupted structure limited internally by the membrana limitans interna, and externally by the membrana terminans retinæ which is the external limit of the hexagonal layer contiguous with the choroidal membrana vitrea. The so-called membrana limitans externa consists of stout connective-tissue fibres and serves as a support to the bacillary layer. Throughout the retina we can distinguish two forms of nerve fibres; the one belonging to the cones, the other to the rods in the bacillary layer. The former kind consists of a sheath containing the cone-fibril supported by radiating fibrillæ surrounded by a protoplasmic mass which is a differentiated and specialized form of the white substance of Schwann; so that we may regard the cone-fibres as specialized medullated fibres, whilst the rod-sheaths contain a fibril which is not surrounded by this protoplasmic substance; and as the rod-fibrils moreover emanate from the rod-sheaths in the bacillary layer as simple axis-

cylinders, we must regard them as non-medullated fibres. The specialized medullated and non-medullated fibres can both be traced as such in the optic nerve, and from the optic nerve through all the layers of the retina to the spherules in the hexagonal layer. The sheaths of the medullated nerve fibres are sustained by the molecular layers, the stout fibres of the so-called membrana limitans externa, and the crystal pigment plexus. These together form a substantial structure, the interstices of which are filled out with delicate networks in the meshes of which granules are suspended, through which the non-medullated axis-cylinders or rod-fibrils run. In the molecular layers the rod-fibrils run through the meshes of the plexus. Both the cone-fibrils (the axis-cylinders of the medullated nerve-fibrils) and the rod-fibrils (or non-medullated fibres) are supported throughout their course by fine radiating fibrillæ. The molecular layers, moreover, evidently play an important part in regulating the blood and lymph supply, as they divide the zone of large blood-vessels from the zone of capillaries, and that again from the non-vascular zone. The rod-fibrils run through the centre of the granules, which are spherical bodies filled with a granular substance insulating and sustaining the fibrils, which are, moreover, there held in position by radiating fibrillæ. The outer granular layer only differs in width in the various portions of the retina, with the exception of the third or inner papillary area in which an additional smaller form of granules is to be found.

The outer molecular layer is a narrow streak of close network of about equal width throughout the retina. Through the meshes of this network the rod-fibrils run supported by radiating fibrillæ, and it is likewise traversed by the cone-sheaths or medullated fibres.

On the inner side of the disc and at about 1 *mm* from it, a special plexus which I have termed the *macula plexus* originates, and continues widening until it comes within 0.2 *mm* of the fovea, where it narrows again, ceasing abruptly at the fovea itself. On the other side of the fovea it appears again, attaining its greatest width at the same distance from it, and then it narrows gradually until the end of the fifth

area is reached. This macula plexus consists of cone-sheaths sloping away from the fovea, the spaces between them being filled with a fine plexus in the meshes of which the rod-fibrils are sustained by radiating fibrillæ.

Between the macula plexus and the outer molecular layer we find a special layer which I have termed the *macula plexus border layer*. In this layer the cone-sheaths run at right angles to the plane of the retina sustained by a plexus through the meshes of which the rod-fibrils run, and they, as well as the cone-sheaths, thence enter the outer molecular layer.

*Remarks Concerning the Annexed Folded Microphotograph.*

Having obtained specimens perfect throughout, from the disc to the end of the fifth system, in a line drawn through the disc and the centre of the fovea, I have selected one of these specimens, and have been able, thanks to a special photographic microscope fitted with a mechanical and rotating stage, to take a series of microphotographs which, exactly adjusted to each other, have rendered it possible for me to show the macula plexus throughout its entire course. The bacillary layer is the only one which, especially in its distal portion, has suffered during the preparation of the specimen. The eye was obtained from a person sixty-five years of age. I mention this because of the shape of the fovea, which, as I hope to show in a future article, varies with age, and to some extent with individuals.

The microphotograph represents the retina magnified exactly 250 diameters, so that all measurements taken on the photograph itself can be correctly calculated as compared with the specimen, or in other words with the eye itself.

By magnifying exactly 250 diameters I have produced a photograph in which 1 *mm* corresponds to 4 $\mu$ in the specimen, or to put it in inches: 1 inch on the photograph = 100 $\mu$ or $\frac{1}{10}$th *mm* on the specimen.

By means of the rotating mechanical stage I brought each separate photograph of the series parallel to the side of the

plate, thus avoiding the curvature which would have rendered the publication of the picture more difficult. As each plate corresponded to about half a millimetre in the specimen the amount cut off by this adjustment is infinitesimal, and can therefore be safely ignored.

## *Measurements of the Macula.*

Although I may be entrenching to some extent on matter which I had reserved for a future article, I think it will be of interest if I now give some indication of the opinions I have so far formed as to the size of the macula and the fovea. The annexed folded microphotograph will assist me in doing so.

There seems to be considerable diversity of opinion as to what we have to understand by the macula and what by the fovea.

If the reader will refer to my first paper on this subject in vol. xxi. of these ARCHIVES, he will find a number of colored drawings of the macula reflex ring and the foveal reflex; and he will find that the difference of color noticeable with the ophthalmoscope over the macula region is limited by the inner edge of the ring. If we therefore measure the diameter of the ring as defined by the inner edge, and reduce it to its actual size and then increase it again by the magnification of the microphotograph, and transfer the measure thus obtained to the microphotograph, we can determine the boundary of the macula.

Now the pictures in vol. xxi. are drawn of a magnification of 10 diameters, and the average diameter is 14 *mm*, so that the area of deeper color—the macula—measures 1.4, which multiplied by 250 = 35 *mm* or 17½ *mm* from the centre of the fovea on either side. This I have indicated by dotted lines, and it will be found to correspond to the spot where the dip first becomes accentuated.

If I measure the ill-defined outer edge of the macula reflex ring in the pictures above referred to, I obtain an average which corresponds to 1.8 *mm* in the eye, which multiplied by 250 = 45 *cm*, which measured off on the microphotograph

corresponds to the place on each side where the dip is first slightly noticeable. The floor of the fovea in the microphotograph measures 7.5 *cm*, which corresponds to 0.3 *mm* in the eye, which is the average I obtain by measuring the foveal reflex in the colored pictures and dividing by 10.

In explanation of the magnification of 10 diameters in the pictures in vol. xxi., I may mention that Helmholtz has calculated the magnification by the direct method as 14.3 diameters; Landolt gives it as 20 diameters; Dimmer's calculation gives 16.6 diameters. As, however, the projected image varies with different observers and with the distance to which it is projected, I have observed the size of the disc and obtained it exactly 10 times the natural size, and then drawn the macula ring to scale. The disc measures on an average 1.5 *mm* when measured with callipers in the enucleated eye, and I obtain the same measurement with the micronometer eye-piece when measuring the disc in my microscopic sections. It is when I saw the disc 15 *mm* in diameter that I have drawn the macula ring as in the pictures referred to.

If we take the distance from the retina to the nodal point in the lens as 15 *mm*, we find that 1.4 *mm* corresponds to 5.4 degrees. The angle corresponding to the area of distinct vision is generally admitted to be slightly over 5 degrees, and I have found this correct when I have tested it.

The dotted lines on the microphotograph, corresponding to 1.4 *mm* in the specimen, indicate the limits of the region which appears darker with the ophthalmoscope, and this also agrees with the area of distinct vision.

We must therefore evidently regard the macula, the seat of acute vision, as corresponding to the dip, and the fovea as the pit in the middle of this macula area.

It is remarkable that nothing but the dip in the retina should indicate the macula, and that nothing in the structure of the retina itself seems to correspond to this dip. The macula plexus reaches far beyond it on both sides, and does not reach its maximum width there where the dip first com-

mences, nor does it correspond to the limits of the fourth or fifth system of the bacillary layer.

I am continuing my work on the subject and may in a future paper be able to indicate some histological peculiarity of the macula other than the dip, but at present I am inclined to think that the acute vision at that spot, and the difference of color noticeable there, may be due to physiological rather than histological conditions.

(*To be continued.*)